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Quarterly Report

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Contract Number: DTPH56-05-T-0001
Prepared for: United States Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Office of Pipeline Safety

Project Title: "Understanding Magnetic Flux Leakage (MFL) Signals from Mechanical Damage in Pipelines"

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For quarterly period ending: March 31, 2007

Progress to Date

This is the second year of a 3 year project aimed at understanding the origin of Magnetic Flux Leakage (MFL) signals from mechanical damage (dents and gouges), with the ultimate goal being to accurately characterize from MFL field inspection data obtained from such damage. MFL dent/gouge signals arise from both the dent/gouge geometry as well as the residual stresses surrounding the defect. In this project, experimental and finite element modeling techniques are used to separate and understand both stress and geometry contributions to the MFL signals.

Work conducted prior to the initiation of this contract by the Queen's University Applied Magnetics Group involved examination of MFL signals from circular dents in steel plate. The first year of the current US DOT PHMSA cofunded effort involved extending this study to include "elongated" dents; specifically, dents having a 2:1 length to width aspect ratio. All experimental work in the first year utilized "laboratory" dents produced in plates using a compression machine at Queen's University. The current (second) year of the project involves extending the study to examine dents in pipeline samples. Sections of dented pipeline have been provided by Gaz de France, who employ a specialized 'calibrated backhoe' unit (termed a 'pipe aggression rig') designed to introduce realistic dents and gouges into pipe sections. As part of this second year, Queen's personnel have traveled to the Gaz de France facilities in St. Denis, France to make MFL measurements on a number of pipeline samples containing well-characterized dents and gouges.

Within the current year, research during the first quarter (July-Sept 2006) involved preparing and upgrading the MFL measuring equipment to make it more robust and portable for the trip to Gaz de France facilities, and to modify it to accommodate the larger geometry and curved nature of the pipeline sample coupons. In addition, the Infolytica MagNet magnetic modeling software license was renewed and considerable work was done to determine how best to build pipeline dent models using MagNet. Gaz de France also conducted stress FEA to provide the necessary inputs for Queen's magnetic FEA models.

In the second quarter (Oct-Dec 2006) MFL equipment modifications were finalized and the equipment shipped to the Gaz de France research facility in St. Denis, France. In December 2006, three members of the Queen's Applied Magnetics Group visited the facility and conducted measurements on dented samples. In addition to the experimental work, further work was done using the Infolytica MagNet software package to model plain dents (dents without gouges) in samples having a pipe geometry.

In the present (third) quarter most of the effort focused on analyzing data gathered from MFL dent measurements made at Gaz de France during the December 2006 visit. Additional work this quarter involved obtaining preliminary MFL measurements from gouged samples, as well as some preliminary MFL modeling work of signals from gouges. This preliminary work is aimed at preparing for the third phase (to be proposed) of this project (July 2007-June 2008), which will focus on modeling and experimental measurements of MFL signals from gouged samples.

A summary of the tasks conducted this quarter is given below:

Task 6.7 Item 28) – Analysis of MFL patterns from dents, obtained from measurements made at Gaz de France in the previous quarter

Task 7.1 (Item 29) – Preliminary modeling of MFL signals from gouges in pipeline sections.

Task 7.2 (Item30) – Preliminary MFL measurements on gouged samples at Gaz de France.

Task 4 (Item 31) – Eighth quarterly report written and submitted.

Task 5 (Item 27) – Annual peer review

Task 4 (Item 31) – Technical review presentation at PRCI Annual meeting in Albany, NY, January 2007.

Payable Milestones

The following payable milestones were completed during this reporting period:

- Annual peer review (Item 27)
- Analysis of MFL patterns from dents, obtained from measurements made at Gaz de France in the previous quarter (Item 28)
- Preliminary modeling results of MFL signals from gouges in pipeline sections (Item 29)
- Preliminary MFL measurements on gouged samples at Gaz de France (Item 30)
- Eighth quarterly report written and submitted (Item 31)